SECTION 8B - VERIFICATION WELL PLUGGING & ABANDONMENT PROCEDURES

8B.1 Description of Plugging Procedures

Upon completion of the project, or at the end of the life of Verification Well #2, the well will be plugged and abandoned to meet all applicable requirements. The need to abandon the well prior to any injection (i.e. during construction) is also a possibility. The plug procedure and materials will be designed to prevent any unwanted fluid movement and to protect any USDWs. The well plugging procedure and design will be updated in the well plugging plan based on any new information gained during well construction and testing. The final plugging plan will be developed after collaboration and interaction with the UIC Program Director; however, to fulfill permit requirements, we propose the preliminary plan which follows.

8B.1.1 Abandonment during Construction

Abandonment during well construction, while sections of the wellbore are uncased could take place while: (1) drilling the surface hole ($\leq$350 ft), (2) drilling intermediate hole ($\leq$5,300 ft), or (3) drilling long-String hole ($\leq$7,500 ft).

During each scenario, the drill string (drill collars, drill pipe, and drill bit) represents the most likely risk for leaving equipment in the hole. Although unlikely, it is possible that a logging tool, core barrel, or other piece of equipment can get stuck and be left in the hole. Every attempt will be made to recover all portions of the string or other equipment prior to abandonment.

If equipment cannot be retrieved and must be abandoned in the wellbore, no unique plugging procedure should be required and the plugs will be placed as specified in the plugging plan. Plug placement will depend upon depth of the hole, the geology and the depth that the equipment was lost in the well. If the well has not penetrated or is not within 100 feet of the caprock, then typically plugging during construction would require placing plugs across any zones capable of producing fluid and at the previous casing shoe. A surface plug will be set and the well filled with drilling mud between the plugs. If the caprock has been penetrated when the well is judged to be lost, the well will be plugged using CO_2-resistant cement from TD to 1,000 feet above the caprock seal using the balanced plug method. This may require setting multiple plugs. If this occurs, each plug will be verified before moving to the next.

If a radioactive logging source is lost in the hole (e.g. a density and/ or neutron porosity logging source), current Nuclear Regulatory Commission (NRC) regulations will be followed. A 300-foot red cement plug will be placed immediately above the lost logging tool. An angled kick-plate will be placed above this plug to divert any subsequent drilling that may coincidentally enter this wellbore. Current NRC regulations require that the surface casing remain extended above the ground surface with an informative ground plate welded to the pipe. The plate includes information to identify what is in the hole. Depending upon where in the well the radioactive source is lost, plugging above the kick-plate will proceed as described above.

Plug Placement Method: The method of placing the plugs in Verification Well #2 is the "Balanced Plug" method. This is a basic plug spotting process that is generally considered more efficient and is consistent with best industry practices.

8B.1.2 Abandonment at End of project

After injection has ceased, the well will be flushed with a kill weight brine fluid. A minimum of three tubing volumes will be injected without exceeding fracture pressure. Detailed plugging procedure is provided in Section 8B.1.4 below. All casing in this well will be cemented to surface and will not be retrievable at abandonment. After injection ceases and after the appropriate post-injection monitoring period is finished, the completion equipment will be removed from the well.

8B.1.3 Type and Quantity of Plugging Materials, Depth Intervals

The volume and depth of the plug or plugs will depend on the final geology and downhole conditions of the well as assessed during construction. Well cementing software (e.g. Schlumberger's CemCade) will be used to model the plugging and aid in the plug design. The cements used for plugging will be tested in the lab prior to plug placement and both wet and dry samples will be collected during plugging for each plug to ensure quality of the plug.

All of the casing strings will be cut off at least 3 feet below the surface, below the plow line. A blanking plate with the required permit information will be welded to the top of the cutoff casing.

8B.1.4 Detailed Plugging and Abandonment Procedures

8B.1.4.1 Notifications, Permits, and Inspections (Prior to Workover or Rig Movement).

Notifications, permits, and inspections are the same for plugging and abandonment during construction and post-injection.

1) Notify the regulatory agency at least 60 days prior to commencing plugging operations. (Note that this timeline will not apply for plugging and abandonment during well construction.) Provide updated plugging plan, if applicable. Ensure proper notifications have been given to all regulatory agencies for rig move.
2) Ensure that the plugging procedure has been reviewed and agreed upon by regulatory agency.
3) Ensure in advance that a pre-site inspection has been performed and the rig company has visited the site and is capable of transporting rig, tanks & ancillary equipment to perform P&A operations. Notify all key third parties of expected work scope, and ensure third party contracts for work are in place prior to move in.
4) Have copies of all government permits prior to initiating operations and maintain on location at all times. Check to see if conditions of approval have been met.
5) Make sure partners (U.S. DOE, EPA and ADM) approvals have been obtained, as applicable.

A site-specific list of facility contacts will be developed and maintained during the life of the project.

8B.1.4.2 Volume Calculations

Volumes will be calculated for specific abandonment wellbore environment based on desired plug diameter and length required. Volume calculations are the same for plug and abandonment during construction and post-injection.

1) Choose the following:
    a. Length of the cement plug desired.
    b. Desired setting depth of base of plug.
    c. Amount of spacer to be pumped ahead of the slurry.

2) Determine the following:
    a. Number of sacks of cement required.
    b. Volume of spacer to be pumped behind the slurry to balance the plug.
    c. Plug length before the pipe is withdrawn.
    d. Length of mud freefall in drill pipe.
    e. Displacement volume required to spot the plug.

8B.1.4.3 Plugging and Abandonment Procedure for "During Construction" Scenario:

Pumping the Cement Job

1. Trip in Hole (TIH) to the desired depth (drill pipe tags the base of the desired plug depth).

2. Shut down circulating trip tank on wellbore.

3. Break circulation and condition mud as required. Circulate at least until the pit levels stabilize.

4. Mix and pump cement and spacers.

5. Displace with the predetermined mud volume.

6. Shut down cementing unit and allow mud to freefall.

7. Near the end of the freefall, begin pulling out. Check to verify if we are pulling dry or wet. Slowly pull the drill string out of the plug and continue trip out of hole (TOH) until 300 ft +/- above the top of the plug. Slowly pump 5-10 bbls to clear the drill pipe.

8. Waiting on cement (WOC) minimum 12 hours, and TIH to tag the plug. If the plug will hold 5-10,000 lbs weight, pull up, circulate 1-2 stands above and continue with next plug.

9. After placing all plugs, pull out of hole (POOH) laying down all drill pipe.

10. Cut off all casings below the plow line (or per local, state or regulatory guidelines), dump 2-5 sacks of neat cement, and weld plate on top of casing stub. Place marker if required.

11. After rig is released, restore site to original condition as possible or per local, state or federal guidelines.

12. Complete plugging forms and send in with charts and all lab information to the regulatory agency as required by permit. Plugging report shall be certified as accurate by ADM and shall be submitted within 60 days after plugging is completed.

8B.1.4.4 Possible Plugging and Abandonment Procedure for "End of Project" Scenario:

At the end of the serviceable life of the verification well, the well will be plugged and abandoned. In summary, the plugging procedure will consist of removing all components of the completion system and then placing cement plugs along the entire length of the well. At the surface the well head will be removed and casing cut off 3 feet below surface. A detailed procedure follows:

1. Move in workover unit with pump and tank.

2. Fill both tubing and annulus with kill weight brine.

3. Nipple down well head and nipple up BOPs.

4. Remove all completion equipment from well. This will require deflating the Westbay packers and removing all Westbay equipment from the well.

5. Keep hole full with workover brine of sufficient density to maintain well control.

6. Pick up 2 7/8" tbg work string (or comparable) and trip in hole to PBTD.

7. Circulate hole two wellbore volumes to ensure that uniform density fluid is in the well.

8. The lower section of the well will be plugged using CO2 resistant cement from TD around 7000ft to around 1000ft above the top of the Eau Claire formation (to approximately 4000 ft). This will be accomplished by placing plugs in 500 ft increments. Using a density of 15.9 ppg slurry with a yield of 1.11 cf/sk, approximately 360 sacks of cement will be required. (3000 ft X .1305 X cu ft/ft x 1.2 excess / 1.11 cf/sk = 423 sacks) Actual cement volume will depend upon actual weight of the casing within the plugged zone. This will require at least six plugs of 500 feet in length. No more than two plugs will be set before cement is allowed to set and plugs verified by setting work string weight down onto the plug.

9. Pull ten stands of tubing (600 ft) out and shut down overnight to wait on cement curing

10. After appropriate waiting period, TIH ten stands and tag the plug. Resume plugging procedure as before and continue placing plugs until the last plug reaches the surface.

11. Nipple down BOPs.

12. Remove all well head components and cut off all casings below the plow line.

13. Finish filling well with cement from the surface if needed. Total of approximately 442 sacks total cement used in all remaining plugs above 4000 feet (4000 ft X .1305 cu ft/ft / 1.18 cu ft/sk = 442 sks) . Cement calculations based on using Class A cement from 4000 ft back to surface with a density of 15.6 ppg and a yield of 1.18 cu ft /sk. Lay down all work string, etc. Clean cellar to where a plate can be welded with well name onto lowest casing string at 3 feet, or as per permitting agency directive.

14. If required, install permanent marker back to surface on which all pertinent well information is inscribed.

15. Fill cellar with topsoil.

16. Rig down workover unit and move out all equipment. Haul off all workover fluids for proper disposal.

17. Reclaim surface to normal grade and reseed location.

18. Complete plugging forms and send in with charts and all lab information to the regulatory agency as required by permit. Plugging report shall be certified as accurate by ADM and shall be submitted within 60 days after plugging is completed.

Note: 7,000 ft 5 ½" 17 #/ft (7000 ft X .1305 cu ft/ft = 914 cu ft) casing requires an estimated 914 cubic feet of cement to fill, 14 plugs.

Approximately five days required from move in to move out, depending on the operations at hand and the physical constraints of the well, weather, and other conditions.